

2. **Papermaking** (grade 2). This activity will take time spread out over a minimum of three days, but if you take longer, the paper mix may go bad (get moldy), so timing is very important. While the activity takes a long time, my experience is that it is one of the most enjoyable experiences of kids of any age and it can certainly reinforce the idea that good scientific investigation is a lot of fun.

There is really only one learning outcome in this activity, but of critical importance in developing the chemical ideas to come: In mixing materials of different properties, you can tell that it is only a mixture because the observed properties of the new paper are the same as the properties of the substances that went into making the paper.

Advance preparation will have to go into this! To make the paper, you will need blenders, simplified deckles, an immersion tub larger than the deckles, 10 oz cups, plenty of water, lots and lots of paper towels, and materials to make the paper from. These materials might include the following: Tissue paper, colored or patterned fabrics, flower petals, very fine sawdust, paper towels, and any other material that can be made very small, and generally made of cellulose. Thus, artificial fibers are poor to use. In addition, while some books suggest dryer lint, my experience shows this is a very bad idea! Glitter of all kinds also works fairly well. Kids will also need scissors.

Note – making the “deckle.” I used a square of wood slats about 10”x10” with nylon screening tightly stretched across and stapled to the edges. Another possibility would be to use a large embroidery hoop, also with screening stapled to it. A proper deckle also contains a matching top part without additional screening to act as a “fence” but I leave this out, and it works fine. You will need to make several deckles for your class!

On the first day, kids choose what to use – they should collect items from what you bring in, but may be asked to bring items of their own choosing. They then need to cut these items into very small pieces, until a 10 oz cup is about $\frac{1}{2}$ or slightly more full. This takes time! Kids also need to list in their notebooks each item they cut up, and particularly the color of the item. Fill the cups with water, cover with plastic wrap and allow to soak 1-2 days, but not longer (!) as the paper mix will get moldy. We found the soaking step really helps.

After the soaking step, have a blender set up with a tub nearby containing several inches of water. Next to the tub you will have several levels of paper towels set up, especially with the top level with exactly two overlapping paper towels. The basin should be able to hold the deckle completely submerged in the water. The blender jar should be slightly less than $\frac{1}{2}$ way filled with water. Pour the paper slurry into the blender jar, cover it well, and blend at a medium setting and pulsing for about a minute. A half minute may be enough. It will take two pairs of hands for this next step. Hold the deckle so that the screen is just below the surface of the water in the tub, then gently pour the blended paper mix onto the center of the deckle. Gently swirl the deckle to distribute the paper around evenly, then lift out of the tub.

I call the next step the “WHAP” step. Everyone has to say “WHAP!” Very sharply invert the deckle and hit it hard onto the overlapping paper towels (while saying WHAP) with the center of your paper aimed at the center of the overlap (this makes it easier to remove the paper towels later on). It may be difficult to remove the deckle from the paper, so you need to very slowly lift it up. A little practice makes this work better, and it depends on the exact composition of the paper. If you are not careful, you may tear the wet paper into shreds and you will have unhappy kids! Once you have removed the deckle, use paper towels to gently pat as much water out of the paper as you can. Then lifting up the paper using the paper towels underneath, transfer to a place where you can allow the paper to dry for a day or two.

The final step is to gently remove the paper from the paper towels under it. Since the supporting paper towels are overlapping, you can peel very gently from the bottom. Again, be very gentle as the paper might rip.

Encourage the students to examine their paper and list its properties alongside the list of substances they used initially. In particular they should notice, and share with others, that the materials they used in making the paper are visible in the paper itself. The paper's properties are a blend of the properties of its

components. New properties have not come about. For example, if there are red threads in the paper, it is because red threads from red fabric were used in making it. Or if glitter is observed in the paper, it is because glitter had been used. What is to be emphasized is that in a mixture, the properties of the components of the mixture are present in the whole mixture.

This should be followed up with other examples of mixtures that are familiar to kids – mixtures containing sugar taste sweet because the sugar is sweet. The color of cake frosting is due to the color of the dyes used. Sometimes when mixing takes place a serious change in properties occurs that cannot be explained by merging the properties of the parts. For example, if you mix vinegar and baking soda, lots of bubbles forms that were not present initially. Or taking a slice of bread and toasting it, the properties change (it browns or maybe even turns black). We can divide all examples of mixing into two kinds, one, such as the making of paper, in which the initial properties do not change, and the other, such as baking soda and vinegar, in which new properties appear.

Lots of further conversation in other science domains are possible here as well, and use opportunities to explore with your students the kinds of changes present in the natural world as your kids encounter them!